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GLASS COMPOSITION CALCULATIONS

By A. K. LYLE

In the glass factory it has been customary to express glass compositions in terms of the weights of the raw materials used, and to many glass makers the tabulation of a chemical analysis has little or no meaning unless the corresponding batch composition is also known.

When the batch consists only of sand, soda, and lime, there is no doubt that the batch composition will give an accurate representation of the glass, but at the present time glasses are complicated by the addition of feldspar,* borax, barytes, and magnesia. Thus, when feldspar and borax are used, other constituents are added to the glass in addition to the wanted alumina and boric oxide, so that a simple statement of the batch mixture does not give very much of an idea of the characteristics of the glass. Then, too, changes in composition due to variations in saltcake and nitre are not readily recognized in batch formulas.

Moreover, in addition to the regular and customary batch ingredients, the use of foreign or off-composition cullet is quite common with many glass manufacturers. Unless cullet is considered as a raw material, and its composition taken into account, the glass composition is likely to be much different from what is expected from the batch mixture.

All of the above contribute to the necessity of judging a glass on the basis of its chemical composition rather than upon the batch formula. Recognizing this, several authors have included in their publications, chapters dealing with methods of calculating glass compositions and batches, but nearly all of them deal with the subject in a manner which does not give a complete picture of the details necessary for practical use. For example, the effects of minor impurities in sand, limestone and feldspar are usually left out entirely, as is also the importance of cullet as one of the batch materials.

In this article, the calculations involved in glass manufacture are considered under three headings: 1. The calculation of batch to glass; 2. The calculation of glass to batch; 3. The calculation of corrections for the use of arbitrary amounts of foreign or off-composition cullet.

1. Batch-To-Glass Calculations

The first requisite for an accurate calculation of a glass composition, is a tabulation of the chemical analyses of all the raw materials used. In most of the descriptions of methods for determining glass composition, theoretical raw materials are used. For example, sand is usually considered as 100 per cent silica while as a matter of fact, most glass sand is about 99.6 per cent silica. Materials such as nitre, soda ash, and borax, being prepared by chemical processes, are very pure, so that theoretical compositions of these materials may be used.

TABLE I. Typical Percentage Compositions of Raw Materials

Material	SiO_2	R_2O_3	CaO	MgO	Na_2O	Ign. Loss
Sand	99.6	0.23	...	...	...	0.17
Soda Ash	...	...	...	...	58.5	...
Limestone (Dolomite)	0.1	0.1	30.4	21.7	...	44.7
Feldspar	68.8	17.5	0.4	...	12.9	0.4
Arsenous Oxide	...	...	...	...	...	100.0
Nitre	...	...	...	...	36.5	...
Saltcake	...	...	...	...	43.6	...

Table I is a tabulation of the chemical analyses of several batch materials. It is understood that the figures used are for example only, and that while the analyses may be typical they are not for accurate calculations.

Having the analyses of the raw materials, it is a

*Preprinting of a chapter to appear in a publication now in preparation for the National Feldspar Association.

TABLE II

Batch Formula		Factors		SiO_2	R_2O_3	CaO	MgO	Na_2O
Sand	1000	0.996	(SiO_2)	996.0	...	...	...	...
		0.0023	(R_2O_3)	...	2.3	...	...	...
Soda Ash	380	0.585	(Na_2O)	...	...	...	...	221.0
		0.001	(SiO_2)	0.2	...	...	...	...
		0.001	(R_2O_3)	...	0.2	...	...	...
Limestone	175	0.304	(CaO)	...	...	53.2	...	...
		0.217	(MgO)	...	...	...	38.0	...
		0.688	(SiO_2)	68.8	...	...	...	...
		0.175	(R_2O_3)	...	17.5	...	...	...
Feldspar	100	0.004	(CaO)	...	...	0.4	...	...
		0.129	(Na_2O)	...	...	...	...	12.9
Arsenic	5	....	....	...	...	...	...	...
Nitre	10	0.365	(Na_2O)	...	...	...	...	3.6
Saltcake	10	0.436	(Na_2O)	...	...	...	...	4.4
TOTALS				1,065.0	20.0	53.6	38.0	241.9

simple matter to multiply the number of pounds of each material used, by factors representing that material, and thus obtain the amounts of the various glass-forming oxides in the glass. Calculations made with the slide rule are satisfactory. Thus 1000 pounds of sand represent 996 pounds of silica (SiO_2), and 2.3 pounds of iron and alumina (R_2O_3). Instead of multiplying 1000 by 99.6 the factor 0.996 is used to obtain 996 pounds. In other words the percentage composition figures are all divided by 100 in order to represent the amount of each constituent oxide per pound of material instead of per hundred pounds as in the percentage tabulation.

Table 2 illustrates the next step in the calculation. The first left-hand column is the batch for which the glass composition is to be found.

By adding the totals of the separate oxides the total weight of glass obtained from the batch is determined:

SiO_2	1065.0
R_2O_3	20.0
CaO	53.6
MgO	38.0
Na_2O	241.9
Total Glass	1419.5

The total weight of glass from the batch is 1419.5 pounds or 14.195, hundreds of pounds. Dividing the total weight of SiO_2, in pounds, by 14.195 gives the number of pounds of SiO_2 in each 100 pounds of glass which is the per cent of silica present in the glass. Similar computation gives the per cent R_2O_3, CaO, MgO, and Na_2O. The total of all the per cents should be 100.0. This part of the calculation is represented in Table 3.

TABLE III

Constituent	Calculation		% Composition
SiO_2	1065.0 / 14.195	=	75.03
R_2O_3	20.0 / 14.195	=	1.41
CaO	53.6 / 14.195	=	3.78
MgO	38.0 / 14.195	=	2.68
Na_2O	241.9 / 14.195	=	17.10
			100.00

This is not the final calculation. Due to some refractory attack, and possibly other changes such as volatilization or dusting during the melting process, or due to peculiarities of the methods of analysis, this first calculated composition will be found to disagree with the actual chemical analysis. A simple correction of the SiO_2 and R_2O_3 figures usually gives a very close approximation to the actual glass analysis. Also, for practical purposes it is not necessary to keep the figures of the second decimal place. In many cases the only corrections necessary are to the silica and alumina (R_2O_3) figures. The correction for the SiO_2 and R_2O_3 usually amounts to from 0.1 per cent to 0.3 per cent and is simply subtracted from the silica and added to the R_2O_3. In the case of the example, let the correction be 0.2 per cent. The corrected calculation will then be:

	Original	Correction	Final Composition Rounded to 0.1%
SiO_2	75.03	—0.2	74.8
R_2O_3	1.41	+0.2	1.6
CaO	3.78	..	3.8
MgO	2.68	..	2.7
Na_2O	17.05	..	17.1

If cullet is used with the batch, it will have to be the same composition as the glass, or else its effect upon the composition will have to be taken into account by considering it as one of the raw materials. Calculations involving cullet are presented in a later section of this paper.

In the sample calculation it will be noted that no provision is made for arsenic or sulphates in the glass. Both of these constituents can be determined by analysis but if the alkali determination is omitted, As_2O_3 and SO_3 will be included in the alkali by difference. The loss of alkali just about compensates for these minor ingredients in most commercial bottle or window glasses.

2. Glass-To-Batch Calculations

The determination of a batch formula from the glass composition is just the reverse of the batch-to-glass calculation, but the process is somewhat more complicated since it involves a determination of, 1. approximate batch composition; 2. a glass composition determination from this batch; and 3. a correction to the approximate batch, first determined.

The first step of the calculation is the determination of a batch that will produce 100 pounds of glass. This can be obtained from the percentage composition of the glass. The figures representing the items in the batch are then multiplied by a factor in order to bring the batch to a basis of 1000 pounds of sand or to any other basis that is desired. The minor ingredients such as salt cake, arsenic and nitre are then added in customary quantities and the batch corrected for these additions.

The method of calculation and other steps in the procedure can best be shown by a sample computation. Let the glass composition wanted be as shown in the third column of Table IV. The first step is to reverse the corrections to the silica and alumina percentages as shown in Table 4. These are the reverse of the corrections for tank block solution, mechanical loss, and so forth, that were applied in the final step of the batch-to-glass calculation.

TABLE IV

		Glass Wanted	Correction	Glass to be Calculated	
Silica	SiO_2	74.9	+0.2	75.1	
Iron & Alumina	R_2O_3	1.6	—0.2	1.4	
Calcia	CaO	3.8	..	3.8	6.5
Magnesia	MgO	2.7	..	2.7	
Alkali	Na_2O	17.0	..	17.0	

In the calculation of batch from glass, there is some choice of raw materials that can be used. For the

alumina (R_2O_3) either alumina hydrate or feldspar could be used. For the calcia and magnesia, limestone and magnesite could be used but since these oxides are seen from the analysis to be present in the same ratio in which they occur in dolomite, either raw or burnt dolomite can be used. It is not necessary at this point to decide the amounts of the minor ingredients, such as salt cake, arsenic and nitre as these can be decided later. To simplify the situation the same materials that were used in Section 1 will be satisfactory. The batch will then contain Sand, Soda ash, Dolomite, Feldspar, Arsenic, Nitre, Saltcake.

Feldspar contributes silica and alkali, in addition to alumina, and since the amount of these is relatively large, the silica and alkali will displace sand and soda ash from the batch. This makes it necessary to first determine the amount of feldspar required.

For the present it is simpler to regard all of the alumina (R_2O_3) as coming from the feldspar. Corrections for the minor amounts of alumina from the dolomite and sand can be made later. From the analysis of the feldspar in Table 1, it is seen that 100 pounds of feldspar will furnish 17.5 pounds of R_2O_3.

The glass composition calls for 1.4 pounds of alumina from feldspar. Therefore, the amount of feldspar required is given by multiplying 1.4 by the factor representing the number of pounds of feldspar per pound of alumina. This operation is indicated in the equation:

$$1.4 \times \frac{100}{17.5} = 8.00$$

Since the feldspar contributes silica, lime and alkali, it is necessary to find the amounts of these derived from eight pounds of feldspar. This operation is indicated in the following calculations:

8.00 x 0.688 = 5.50 SiO_2 from feldspar
8.00 x 0.004 = 0.03 CaO " "
8.00 x 0.129 = 1.03 Alkali " "

Before proceeding with the remainder of the calculations, it is necessary to subtract the amounts of SiO_2, CaO, and alkali accompanying the feldspar, from the amounts needed by the glass. The complete calculations are indicated in Table 5.

Collecting the italicized items from Table 5, the approximate batch for 100 pounds of glass is:—Sand 69.89, Soda Ash 27.30, Dolomite 12.42, Feldspar 8.00.

Dividing each of the items by 69.89, and multiplying by 1000, will convert this batch to a 1000 pounds-of-sand basis. The batch will then be:—

Material	Amount	Calculation	1000 Pound Basis
Sand	69.89	$\frac{69.89}{69.89} \times 1000 =$	1000
Soda Ash	27.30	$\frac{27.30}{69.89} \times 1000 =$	391
Dolomite	12.42	$\frac{12.42}{69.89} \times 1000 =$	178
Feldspar	8.00	$\frac{8.00}{69.89} \times 1000 =$	115

This batch contains no arsenic, nitre or Saltcake. Let five pounds of Arsenic, 10 pounds of Nitre, and 10 pounds of Saltcake be added.

While the arsenic in these calculations is ordinarily considered as adding nothing to the glass, nitre and Saltcake furnish alkali.

10 nitre = 10 x 0.365 = 3.65 pound Na_2O
$3.65 \times \frac{100}{58.5} = 6.24$ soda ash
10 salt cake = 10 x 0.436 = 4.36 pound Na_2O
$4.36 \times \frac{100}{58.5} = 7.46$ soda ash
13.70 soda ash

Soda ash amounting 13.7 or about 14 pounds must be taken from the batch when the salt cake and nitre are added. The batch will then be:

1000 Pound Basis		Changes	Approximate Batch
Sand	1000	..	1000
Soda Ash	391	—14	377
Dolomite	178	..	178
Feldspar	115	..	115
Arsenic	none	+ 5	5
Nitre	none	+10	10
Salt Cake	none	+10	10

This batch should be close to the desired composition,

TABLE V

Order of Calculation	Composition	Correction	Calculation	Amt. of Material	Add. Oxides
(1) R_2O_3	1.4		$1.4 \times \frac{100}{17.5} =$	8.00 *Feldspar*	
				8.00 x 0.688 = 5.50	SiO_2
				8.00 x 0.004 = 0.03	CaO
				8.00 x 0.129 = 1.03	Alkali
(2) CaO-MgO	6.5	—0.03 (from feldspar)	= 6.47		
			$6.47 \times \frac{100}{52.1} =$	12.42 *Dolomite*	
				12.42 x 0.001 = 0.01	SiO_2
(3) SiO_2	75.1	—5.50 (from feldspar)			
		— .01 (from delomite)			
	75.1	—5.51	= 69.59		
			$69.59 \times \frac{100}{99.6} =$	69.89 *Sand*	
(4) Na_2O-K_2O	17.0	—1.03 (from feldspar)	= 15.97		
			$15.97 \times \frac{100}{58.5} =$	27.30 *Soda ash*	

but since we did not consider all of the impurities in the materials it is necessary to check these results by calculating the glass composition as shown in Table 6.

TABLE VI

Batch		SiO_2	R_2O_3	CaO-MgO	Na_2O
Sand	1000	996.0	2.3	...	...
Soda	377	...	...	...	220.6
Dolomite	178	0.2	0.2	92.8	...
Feldspar	115	79.1	20.2	0.5	14.8
Arsenic	5	...	...	...	...
Nitre	10	...	...	...	3.6
Salt cake	10	...	...	...	4.4
Totals	1695	1075.3	22.7	93.3	243.4
		22.7			
		93.3			
		243.4			
Total Glass		1434.7			

The composition is determined by following the operations indicated in Table 3.

Calculated Composition:		
	SiO_2	74.95
	R_2O_3	1.58
	CaO, MgO	6.50
	Na_2O	16.97
		100.00

The calculated composition is low in silica, and high in alumina, so that further corrections are necessary.

	Calculation Wanted	—	Calculation Found	=	Change Necessary
SiO_2	75.1	—	74.95	=	+.15
R_2O_3	1.4	—	1.58	=	—.18
CaO-MgO	6.5	—	6.50	=	.00
Na_2O	17.0	—	16.97	=	+.03

Here again it is necessary to calculate the alumina change first.

Change Necessary	Calculation	Change in Batch
(1) —0.18 R_2O_3	$-0.18 \times \frac{100}{17.5} = -1.03$	*pounds of feldspar*
(2) +0.15 SiO_2		$1.03 \times 0.688 = 0.71\ SiO_2$
+0.71 SiO_2 from feldspar		$1.03 \times 0.129 = 0.13\ Na_2O$
+0.86 SiO_2	$+0.86 \times \frac{100}{99.6} = +0.86$	*Sand*
(3) +0.03 Na_2O		
+0.13 Na_2O from feldspar		
+0.16 Na_2O	$+0.16 \times \frac{100}{58.5} = +0.274$	*Soda Ash*

The italicized items are the necessary corrections for 100 pounds of glass, but in the calculation of the glass from batch, the batch is shown to produce 14.347 hundreds of pounds of glass. Multiplying the hundred pound correction by 14.35 will give the total correction to be made.

Sand	+ 0.86	x 14.35	= 12.3	or + 12	pounds
Soda ash	+ 0.274	x 14.35	= 3.9	or + 4	"
Feldspar	— 1.03	x 14.35	= 14.3	or — 15	"

These corrections are then added to the calculated batch to give the batch that will produce the desired glass composition. The corrected batch can then be recalculated to a 1000-pound sand basis.

Batch		Correction	New Batch	Final Batch 1000-Pound Sand Basis
Sand	1000	+12	1012	1000
Soda ash	377	+ 4	381	377
Dolomite	178	none	178	176
Feldspar	115	—15	100	99
Arsenic	5	none	5	5
Nitre	10	none	10	10
Salt cake	10	none	10	10

The final batch is very close to the batch with which the calculation started under Section 1. If the batch is rounded to the nearest five pounds it will agree exactly with the original batch.

3. Calculation of Batch Changes Involving the Use of Cullet

The third type of batch calculation is used for correcting batch compositions made necessary by a change in the chemical analysis of one of the materials. Such calculations are used when cullet differing from the regular glass composition is used in the batch. Cullet is a raw material, just as is feldspar, so that its composition must be taken into consideration. However, it differs from ordinary raw materials in that the amount used can be varied at will, providing necessary corrections are made in the batch. For example, a certain lot of cullet may have the following analysis:

SiO_2	73.5
R_2O_3	0.7
CaO, MgO	9.3
Na_2O	16.5

This cullet is to be used in a batch to produce glass of the following composition,

SiO_2	74.8
R_2O_3	1.6
CaO, MgO	6.5
Na_2O	17.1

The changes necessary, and the method of calculating them, are shown in the tabulation.

	Composition Desired	—	Composition Cullet	=	Necessary Change
SiO_2	74.8	—	73.5	=	+1.3
R_2O_3	1.6	—	0.7	=	+0.9
CaO, MgO	6.5	—	9.3	=	—2.8
Na_2O	17.1	—	16.5	=	+0.6

It is seen that it is necessary to add silica, R_2O_3, and soda while the total of lime plus magnesia, must be decreased. These changes can be calculated just as if they comprised a glass composition, except that attention must be given to whether the material is to be added or subtracted from the batch.

Collecting the items italicized in the table on the following page, the changes for 100 pounds of cullet are: Sand —2.3 pounds, Soda Ash —0.1 pound, Dolomite —5.6 pounds, Feldspar +5.1 pounds.

If it is decided to use 350 pounds of this cullet in the batch, the alterations to the batch are obtained by multiplying each correction by 3.50.

Order of Calculation	Change	Correction	Calculation	Amt. of Material	Add. Oxides
(1) R_2O_3	+.09		$0.9 \times \frac{100}{17.5}$	= +5.14 *Feldspar*	5.14 x .688 = —3.54 SiO_2 5.14 x .004 = — .02 CaO 5.14 x .129 = — .66 Alkali
(2) CaO-MgO	—2.9		$-2.9 \times \frac{100}{52.1}$	= —5.57 *Dolomite*	
(3) SiO_2	+1.3	—3.54 (from feldspar) = —2.24	$-2.24 \times \frac{100}{99.6}$	= —2.25 *Sand*	
(4) Na_2O-K_2O	+0.6	—0.66 (from feldspar) = —0.06	$-0.06 \times \frac{100}{58.5}$	= —0.10 *Soda Ash*	

Material	*Calculation*	*Correction*
Sand	—2.3 x 3.50 =	— 8.0 pounds
Soda	—0.1 x 3.50 =	— 0.4 "
Dolomite	—5.6 x 3.50 =	—19.6 "
Feldspar	+5.1 x 3.50 =	+17.9 "

The corrections indicated, when added to the original batch will give the corrected batch formula.

	Original Batch	Change	Batch with Cullet	1000 lb. Corrected Batch	Final Rounded
Sand	1000	— 8.0	992.0	1000	1000
Soda Ash	380	— 0.4	379.6	383	385
Dolomite	175	— 19.6	155.4	157	155
Feldspar	100	+ 17.9	117.9	119	120
Saltcake	10	...	10	10	10
Arsenic	5	...	5	5	5
Nitre	10	...	10	10	10
Cullet	none	+350	350	353	350

In order to check this calculation, the batch, including the cullet, can be calculated to the glass composition it will produce, and further corrections made if necessary.

In the case of cullet containing oxides not present in the regular glass composition, some allowances will have to be made. For instance, cullet may contain barium and boric oxide that are not present in the original batch, or the ratio of lime to magnesia may be different. In general, such cullet cannot be used, but if the amounts or differences are small the lime, magnesia and barium may be totaled and the calculations made as total lime. For purposes of calculation, boric oxide can be added to the alkali, if the amount of cullet to be used is not very large. In many bottle glasses the ratio of lime to magnesia, or the amount of magnesia, can be varied within certain limits so that cullet containing little or no magnesia can be used.

DR. HOSTETTER JOINS HARTFORD-EMPIRE

Dr. John C. Hostetter, for many years the leader in the research and development program of the Corning Glass Works, has been elected Vice President in Charge of Research and Development of the Hartford-Empire Co., Hartford, Conn. according to an announcement by officers of the Corning Glass Works. Dr. Hostetter will begin his new duties shortly after the first of the new year. The administration of Corning's research policy will revert to Dr. E. C. Sullivan, Vice Chairman of the Board of Directors, and the organizer and former director of its development and research department.

The nomination and selection of Dr. Hostetter as director of the research and development policies of Hartford-Empire is a tribute to his unique position in the glass industry. Trained in pure science, with a background of work in the Geophysical Laboratory of the Carnegie Institution, at the United States Bureau of Standards, and in the Optical Section of the War Industries Board, Doctor Hostetter has attained a position of equal experience in process engineering and plant operation. He has directed extensive research programs coordinating the activities of chemists, physicists, and engineers. During his many years with Corning Glass Works, Dr. Hostetter has been successively manager of the Steuben Division, assistant to the Vice President in Charge of Production, manager of the Rhode Island Division, manager of Bulb and Tubing Production, including supervision of this work at the Rhode Island, Wellsboro, and Corning divisions. Since 1930 he has been Director of Development and Research.

Simultaneously with Doctor Hostetter's election, the Hartford-Empire Co. has advanced to a vice presidency its chief engineer, Karl E. Peiler, who has been with the company since its origin. Mr. Peiler invented the company's basic feeding machine—the so-called "Paddle Needle Feeder." Important new developments significant to the glass industry as a whole are said to be now under way at Hartford-Empire.

At the same time other changes in the executive personnel were made known: Robson D. Brown becomes Vice President and Patent Counsel, Roger M. Eldred becomes a Vice President and Theodore L. Champeau, who was formerly Assistant Treasurer, becomes Treasurer. Another new officer is A. Morgan Pease who has been named Assistant Treasurer, in charge of the License Department.

PORTABLE TELESCOPE AT CORNELL

Cornell University physicists have recently completed what they term "the lighest portable telescope of usable astronomical size in the world." The instrument is said to be light enough to be transported to any point where astronomincal conditions are most favorable. The girders of the frame are of a light metal and weigh 20 pounds each, light enough for men or a pack train to carry. It is equipped with a 24-inch mirror poured from the same melt that went into the famous 200-inch disk for Mt. Wilson. The mirror is coated with aluminum and will reflect the light gathered on it to an eye-piece eight feet away.

Word comes from Canada that remarkable progress is being made in the use of glass as a base for false teeth.

THE HYDROGEN FACTOR IN INCOMPLETE COMBUSTION

It has been the assumption of combustion engineers that because hydrogen is a very active gas it burns with considerably more rapidity than carbon monoxide, and it therefore will not be present in the flue gas when incomplete combustion conditions exist. This assumption is no longer true as it has been found that as soon as carbon monoxide appears, even in the smallest quantity, hydrogen also appears, except of course in the case of fuels containing comparatively little hydrogen.

Much evidence showing that this appearance of hydrogen along with carbon monoxide is the rule rather than the exception has been accumulated through the use of mechanical or thermo-electrical types of carbon dioxide recorders installed in boilers, open hearth and glass furnaces. With these types of instruments, as soon as the slightest amount of unconsumed combustible material appears in the flue gases, the carbon dioxide readings will drop to zero or in some cases show a negative amount of carbon dioxide. The upset of the carbon dioxide reading is caused by the fact that hydrogen is very light and its presence in the flue gases thereby upsets the readings of the density meter in the case of mechanical carbon dioxide recorders. In the case of the thermo-electric type of recorder the thermal conductivity of hydrogen is very different from that of carbon dioxide. This large difference in conductivities upsets the carbon dioxide reading of this type of instrument and indicates the presence of hydrogen.

The fuels used in the glass industry, such as fuel oil, producer gas, natural gas and in some few instances, oil gas, coal gas and coke oven gas all contain appreciable amounts of hydrogen either free or combined as hydrocarbons (Table I). The imperfect combustion of these fuels will result in the formation of unoxidized hydrogen. In the case of fuels containing large amounts of free hydrogen, for example producer gas, it is obvious that the lack of the necessary oxygen from complete combustion will allow combustible material and therefore unconsumed hydrogen to pass into the flue gases.

With fuels containing hydrogen in the form of hydrocarbons imperfect combustion forms free hydrogen in the following manner: when hydrocarbons burn there is first a combination of oxygen with the hydrocarbon to form unstable hydroxylated compounds which in turn produce aldehydes. The latter break down into formaldehyde. With a deficiency of oxygen the formaldehyde may break down thermally to form carbon monoxide and hydrogen. The hydrocarbons may also decompose directly into carbon and hydrogen (a smoky flame is evidence of this type of decomposition) through cracking. It is especially rapid at the higher temperatures.

Fuel oil also acts in the same manner as the hydrocarbons. Vaporization of the oil changes it into gaseous hydrocarbons which will either crack into carbon and hydrogen; decompose into carbon monoxide and hydrogen or burn to carbon dioxide and water depending upon the amount of oxygen given to the fuel.

The neglect of taking into account this fact, i.e., that hydrogen does exist in the flue gases when carbon monoxide is present has led to serious errors in the calculations of furnace heat losses. Waste heat loss calculations of glass furnaces in which the loss due to the presence of carbon monoxide only is determined are therefore low. As an example of the extent of this error the work of Houghton[1] is quoted. Houghton's curves showing the loss in boiler efficiency due to unburned flue gas when measured as usual and when the hydrogen factor is considered are self explanatory and are shown in Fig. I.

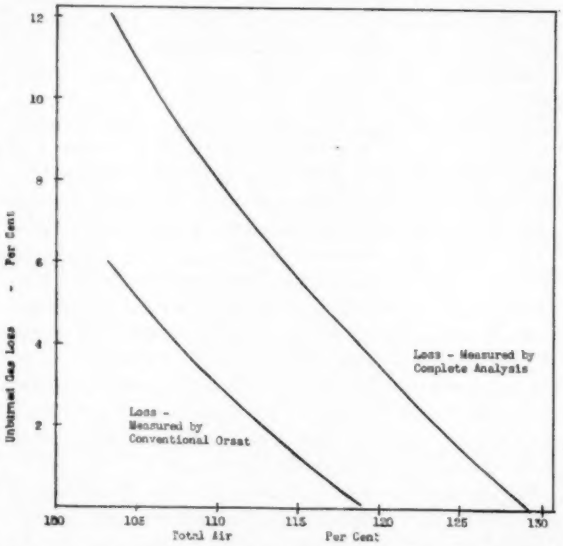


Fig. 1. Curves showing loss in boiler efficiency due to unburned flue gas. (After Houghton).

Trinks[2] from the results of a series of special tests in which he found that the amount of hydrogen and of carbon monoxide in the flue gases of imperfectly oxidized fuels is practically alike except for fuels very poor in hydrogen, has calculated the resulting heat loss (Table II). This table shows the loss due to uncon-

(*Continued on page* 16)

TABLE I. COMPOSITION OF TYPICAL GLASS FURNACE FUELS.

Fuel	CH_4	C_2H_6	C_3H_8	C_2H_4	CO	CO_2	H_2	O_2	N_2
Coal gas	34.0	..	..	6.6	9.0	1.1	47.0		2.3
Coke oven gas	33.9	..	..	5.2	6.1	2.6	47.9	0.6	3.7
Oil gas	27.0	..	..	2.7	10.6	2.8	53.5	..	3.4
Producer gas	2.6	..	..	0.4	22.0	5.7	10.5	..	58.8
Natural gas	..	31.8	77.7	..	..	..	..	..	0.5
Natural gas	32.3	67.0	..	..	..	..	..	..	0.7

DECORATIVE GLASS PANELS ON R. M. S. QUEEN MARY

Although the great development of glass as a versatile raw material capable of myriad uses is comparatively new, the story of glass as a decorative material is as old as Babylon. Today glass has perhaps become more famous as an industrial material than as the raw stuff from which artists work. Illustrated on this page are some of the very beautiful glass murals to be found on the super-liner, "Queen Mary."

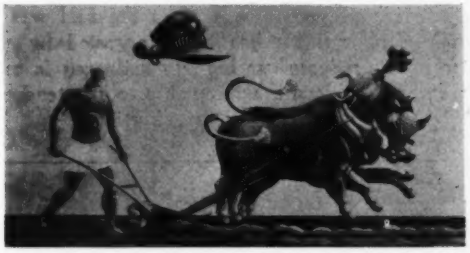
The modern technique of tinting, etching and sand-blasting makes glass particularly well adapted as a medium for decorative schemes in the modern style, and has been used most advantageously on the "Queen Mary." All the glass, with the exception of the pink-flashed opal glass and pressed glass aboard, was manufactured by the London Sand-blast Decorative Works, Ltd., England, from designs executed by prominent British artists.

Above, may be seen artists checking the measurements on a virile design of Jupiter riding a sea horse. When the design by Jan Juta, young South African artist, was completed, it was transferred to glass and etched into the surface. Located in the Tea Dance Room, its beautiful dull grays, silver and whites make it a striking panel.

● This decorative mural map of the North Atlantic is located in the Main Restaurant. Painted in bold formalistic style by Macdonald Gill, a British artist well known for his decorative maps in the Houses of Parliament, it has a mobile, illuminated glass model of the "Queen Mary" which marks the progress of the voyage. The model is made from solid crystal glass, 4 x 2 x 1½ inches.

● One of the decorative glass panels designed by C. Cameron Baillie for the Tourist Swimming Pool. The exquisite marine effect is further enhanced by judicious lighting in back of the panel. This is one of three panels which together form a most interesting focal point at the end of the pool.

● The story of Jason and the Golden Fleece is told in some exquisite panels designed by J. Drew, a coming British artist. The front surface of the plate glass has been slightly dimmed to give a diffused effect. Below, Jason is depicted plowing the field of Ares with the brazen footed bulls.



● Jason is here depicted sowing the plowed field with dragon's teeth in order to fulfill King Aeetes' mandate before regaining the Golden Fleece. In another group, companion panels depict two scenes in the return of Jason with Medea and the Golden Fleece. There is a decided modern trend in the design of all these panels.

● One of the four largest sculptured glass panels ever executed in England. The four panels represent the four elements: Earth, Fire, Air and Water. Designed by Walter and Donald Gilbert and W. A. Riley, these panels are located in the Cabin Class Restaurant.

THE HYDROGEN FACTOR

(*Concluded from page* 14)

sumed combustible when there is one per cent of carbon monoxide present in the flue gases. The left hand column indicates the total loss due to carbon monoxide and hydrogen and the right hand column the loss when it is assumed that the hydrogen is all burnt. The actual flue gas loss is approximately 90 per cent greater than the ordinary method of calculation would show.

While the danger of imperfect combustion of the fuel with the resulting development of hydrogen can be readily seen when the heat losses are converted into dollars and cents, it is highly probable that a larger unseen and difficult to calculate loss also can take place. Hydrogen more than any other gas is very susceptible to flameless catalytic "surface combustion" when it comes into contact with red hot brickwork. The intense local heat produced through the surface combustion of hydrogen can be very harmful to the refractory material upon which it is taking place. It is very possible that some of the excessive wear of glass furnace walls, drowns, ports and the hotter portions of the regenerators may be due to or at least accelerated by surface combustion of hydrogen formed when the fuel was being imperfectly burnt. It has been suggested by several writers that producer gas high in hydrogen is undesirable for glass furnace heating due to the tendency of hydrogen to undergo surface combustion.

TABLE II.

FUEL	Heat loss indicated by presence in dry flue gases (when there is no excess or deficiency of air) of— 1% CO, 1% H_2 % of higher heat value	1% CO, No H_2 % of higher heat value
Oil	5.53	2.95
Natural gas	5.02	2.68
By-product coke oven gas	4.78	2.50
Producer gas (clean)	7.50	3.71
Producer gas (raw)	7.50	3.71
Blue water gas	4.60	2.60

As a check against imperfect combustion and the development of hydrogen, a mechanical (density type) or thermo-electrical type carbon dioxide recorder may be installed. As has been shown, the least trace of hydrogen is sufficient to upset the carbon dioxide reading and the presence of hydrogen is quickly indicated. It is advisable to install the gas sampling line in such a manner that a composite sample of the flue gas from each port is obtained. This is especially true in the case of fuel oil installations where a burner in one port may get out of adjustment. Where Orsat determinations are part of the routine it is advisable to make a complete analysis of the flue gases whenever large amounts of carbon monoxide are detected. Complete analysis of the flue gas as it enters the downtakes may be made when it is suspected that surface combustion of the hydrogen in the unburned combustible is taking place in this region.

[1]Presented before the International Coal Conference, Carnegie Institute of Technology, Nov. 1931.
[2]Fuels and Furnaces, June, 1932.

FIREPOLISHING THIN WARE*

The delicate operation of glazing or fire polishing thin walled glassware has defied all efforts at mechanizing for a great many years, because the glazing heat approximates the softening point of the wall so closely. Expensive hand labor was the only answer until recently when a new principle was developed and applied. This consists of cooling the inside of the ware with closely controlled air jets so that the article holds its shape and does not collapse while the exterior is subjected to the required temperatures, which are above the fusing point. Machines are now built, incorporating this principle, and they are continuous in operation and automatic as to temperature control. They are fired with gas fuel.

Two of these machines known as Continental Glazers are in continuous operation in the plant of the Indiana Glass Co., Dunkirk, Ind. The machine consists of a circular steel frame with a vertical shaft locating a rotating table on rollers carried by the frame. This table in turn carries a horizontal insulating refractory ring in which rides 40 or 50 upright spindles located on the table so as to move with it. These spindles are rotated by a separate chain drive so that their speed of rotation can be controlled separately from that of the table. The advantages of independent control of spindle rotation is considerable when the size and section of the articles to be treated vary.

On top of each spindle is a socket in which the article to be glazed is placed. These sockets move within a stationary inverted ring-shaped enclosure of insulating refractory material which acts as a furnace. This doughnut shaped housing or furnace is suspended by a series of vertical, hand controlled screws, by which it is raised or lowered in reference to the moving refractory ring and to accommodate different sizes of work.

Heat is supplied by a series of automatically adjustable gas burners arranged as to direct a wedge-shaped flame of high temperature onto the ware. These burners are placed in two rows so that the ware passes between and at the same time revolves at a controlled rate of speed as it travels. The table operates intermittently, moving through a given number of positions and then hesitating for a predetermined period before resuming. During the periods of rest a series of vertical tubes descend and cooling air is forced into the interior of the ware. This carries away the necessary amount of heat without affecting the operation of the gas burners.

This machine is interlocked so that the different operations follow successively and the control is timed to coincide with the operating speed of the press which forms the ware. A mechanism in the form of an arm and air suction device transfers the ware from the forming press to the glazing machine.

An unusually good firepolish is said to be obtained even on relatively thin ware by this machine.

* Data for this brief description was furnished by J. B. Nealey of the American Gas Association.

The great mineral wealth of southeastern New Mexico is dramatized in a new elevation map of that area recently released by the Department of the Interior. In addition to having the largest producing potash mines in the Western Hemisphere, it produces more petroleum than all the other Rocky Mountain states combined and has one of the largest gas reserves in the United States.

THE MANUFACTURE, PROCESSING, AND USE OF GLASS FIBERS

By DIPL.-ING. G. V. PAZSICZKY

Glass fibers and the goods prepared from them can no longer be given a single name, for today glass fibers of so many different varieties are being manufactured and their appearance is accordingly so varied that a variety of names are required. Thus we find the names of spun yarn, silk, wool, yarn, hair, wadding, felt, fibers, and so forth in combination with "glass" as names for glass fibers.

Devices for Drawing Single Fibers

The production of glass fibers has been known for several centuries. It originated when the end of a glass rod was heated in a flame and brought into a workable condition; by means of tongs or some such device, the hot end of the rod was drawn out with a rapid movement into a thin thread. If this movement is repeated often enough, a number of threads are accumulated which are as long as the limitations of arm movement will permit and which according to the speed of the arm movement (drawing speed) come out thinner or thicker. This represents, of course, an intermittent process.

Later, a drum, turned either by hand or by a foot pedal was used, and on this the drawn glass thread was held by friction. The drum drew threads continuously for a long time. If the thread broke because of a current of air, or imperfections in the glass, or any accident in the work, it had to be renewed in the above described manner. Since, of course, during this operation, glass in the form of a thread was drawn from the heated end of the glass rod which drew out to a point, it was obviously necessary to provide for a corresponding forward movement of the rod in the direction of the drawing.

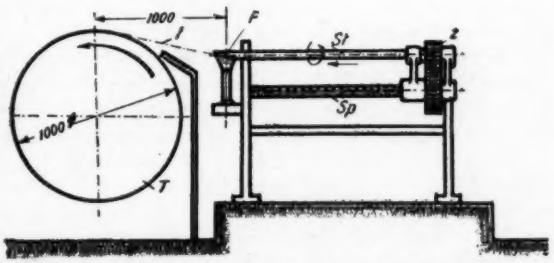


Fig. 1. Drawing fibers from heated glass rod. St, glass rod; F, gas flame; T, Drum (drawing speed, c. 15m./sec.).

It is apparent, therefore, that the process of drawing threads has not the least thing to do with spinning (a matter of twisting together several fibers), and it is therefore only inaccurately called, "glass spinning." The glass is not spun, but drawn out into thin threads.

The glass threads made according to the last-described method were long, straight, and lustrous. Even if the glass out of which the threads had been drawn was bright and transparent, the threads made from it were, nevertheless, bright, glistening, and non-transparent. It was called spun glass, and later, quite often, glass silk. During the machine age this process of drawing glass threads was developed so far that at length not only a single glass rod, but a great number of rods, could be drawn to threads at the same time. To this end 20-30 glass rods are heated at one end by glass flames or the like, turned at the same time, and shoved forward to keep pace with the withdrawal of glass from the heated portion (Fig. 1.)

Replacement of broken threads or the initiation of the drawing process is accomplished by hand, by means of tongs or a glass rod. One overseer can serve as many as four machines. Of course, according to the size of the glass rods, their heating, and the speed of drawing, there are limits to the size of the threads, which vary between 0.01 and 0.04 mm.

If, instead of a single glass rod, two rods of different glasses are set up together in the flame, and these are drawn together into a single thread, the thread so developed, because of the different coefficients of expansion of the two glasses, possesses a good deal of strain which causes the thread to roll and curl upon itself. For this purpose, lead glass as the softer, and borosilicate as the harder glass, are taken together. The curled and coiled glass threads give an impression of long, curly, silvery hair. This has been called, accordingly, "fairy's hair," "angel hair," and "glass wool." Since the coiling arises from tension in the glass, the threads, in contrast to the long, straight threads, are not especially durable.

The desirable properties of glass threads lead to their application, in technology, for a variety of purposes in great quantities, but they must be produced cheaply in order to have a broad field of use. Thus the effort of the manufacturer was directed to economy, not only in the raw material (the rods), but in labor and fuel.

The rods were cheapened by making thick rods of 20-25 mm. diameter instead of the original 3-8 mm. Moreover, instead of heating the rods singly, they were placed in a heated multiple-rope press, and forced out in a number of thin rods whereby the drawing and the heating were made economical.

The process of manufacture was first materially improved when it was observed that if one heated the lower end of a vertically suspended glass rod, a drop formed which pulled itself away and in its fall drew a thread behind it. The application of this phenomenon in thread drawing made the renewal of the thread practically automatic (Fig. 2.)

Thus the number of rods set up in a single machine, to be looked after by one person, became multiplied.

Furnaces for Making Glass Threads

Efforts were long continued to use as starting material, instead of glass rods, the molten glass mass itself in the drawing of threads. (Fig. 3.)

Small and larger furnaces were built for this purpose. With the large furnaces, it was not considered that for

* Translated from Glastech. Ber., June, 1936, by Dr. Samuel R. Scholes.

the drawing of glass threads a good deal of room would be needed for the placement of flowing nozzles. There was necessary, also, very large furnaces, in comparison with their melting capacity, which required a great deal of fuel, and in which a degree of temperature, regulated within 20° C., was required, although very difficult to maintain. The result was a difficult problem; substitutions and repairs were hard to make and very expensive.

On account of the severe difficulties presented by large-scale melting, (*Illustrated by drawings of the furnace in the original paper—Ed.*), tnese have been replaced by smaller furnaces for whose design numerous patents in Germany and in foreign countries have been allowed. Claims are made especially for processes of heating and for the form of the furnaces, since upon these two matters depends, by and large, the successful operation of a glass-thread factory. Furnace dimensions play an important part; especially important is the arrangement and the position of the heating device. Since we are dealing here with a secret process which has been carefully guarded, the various manufacturing steps can be described only in principle.

We find furnaces with gas, oil, and electrical heating, and combinations of these. The furnaces have large flames or many small ones. Firing is direct or indirect. Electrical heating is applied mostly as resistance heating, and the elements are either inside the container protected from the glass bath, or external elements. The furnace can be made of material which conducts electricity and becomes, itself, the resistance in the circuit. If the heating is internal, less current is needed, but the apparatus is very hard to control and when once it has been started in operation, cannot be stopped without serious loss. External elements provide a safe construction but are not so economical in power consumption. If the tank itself is constructed as the heating resistance, a simple construction is accomplished, which is not so susceptible to careless operation.

Apparatus for Simultaneous Production of Numerous Fibers

All of the processes described are based upon the drawing of single threads. The threads were of indefinite length, and each one is produced separate from the rest. For the past 30 years developments have been in processes leading to the production of a great number of fibers at the same time without a drawing apparatus, that is, without a winding drum. The first patents for the production of glass fibers by means of centrifugal force were issued about 30 years ago, but only in recent times have practical operating machines of this sort been built, so that today, glass fibers are being made by centrifugation. It is important in the development of this art that the threads should be as long and of as uniform thickness as possible; little drops and shot [slugs], even though a minimum size, must be prevented. The operating principle is that a stream of fluid glass flows upon a rapidly revolving refractory disk. (Fig. 4.)

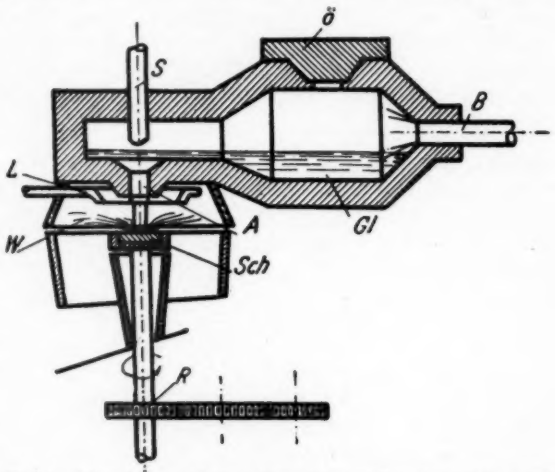
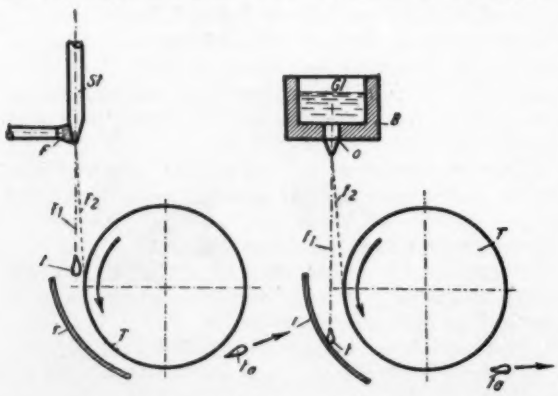


Fig. 4. Manufacture of glass fibers by centrifugation; Sch, centrifugal disk.

The disk accomplishes the centrifugation and drawing of the fluid glass into thin threads. Since the centrifugal force does not concentrate itself upon a single point of the centrifugal disk, but works equally upon the entire surface, the threads do not form separately from each other; but simultaneously there are thrown out, threads that are long and short, twisted together, which give the effect of a wool or felt; hence the designation of this product as "glass wadding."

There has been no lack of effort to produce glass threads of this sort with air pressure. That is, compressed air has been used to shred the glass into fine fibers. Apparatus has been constructed similar to a flower spray, in which a vertical and a horizontal pipe meet at one point. The former dips into the liquid glass, and through the latter, compressed air is blown. At the point where the two pipes come together, there is, thereby, produced a vacuum in the vertical pipe which brings the liquid glass into the stream of air where it is blown into threads. However, because of the sudden swinging of the glass stream from the vertical to the horizontal, no regular threading of the glass took place. Consequently, nowadays the stream of glass is allowed to flow vertically, and the air is blown concentrically around the stream through a nozzle. The glass nozzle in this device must be constructed with especial care, from a noble metal (platinum), in order that chemical contamination in the fine nozzle may be prevented. The nozzles are also especially heated so that the glass is exceptionally fluid. The fibers produced by this method have a woolly appearance, similar to a mass of wool ready for spinning, before it has been drawn into threads; it is therefore called, "glass wool."

Figs. 5 to 8 show how this procedure operates. Fig. 5 is a front view, and Fig. 6 is a longitudinal section.



Figs. 2 and 3. Drawing fibers by developing from falling drop.

Fig. 7 portrays the blowing apparatus in longitudinal section; Fig. 8 is a cross-section of the same. The furnace, O, is a so-called continuous tank, for a minimum pull of two tons in 24 hours. The blowing of glass wool is uninterrupted. At E the batch is fed in, and it is kept away from the working end by the usual bridge. The melting chamber is heated by burner B_1, and burner B_2, maintains uniform temperature in the working chamber, A. Beneath the working chamber are flow-spouts O for the fluid glass, brought out through nozzles in the platinum plate, D. The diameter of the holes in the plate, according to the type of wool to be made, varies between 1.01 and 1.77 mm.

In order that these orifices may not be clogged by stones or foreign bodies in the glass, there is placed above the platinum plate (which has a V form) a filter screen, f, whose meshes are smaller than the orifices. Since the glass must be very fluid as it leaves the nozzles or orifices, the nozzle plate is made the resistance in a low-voltage electrical circuit, and thereby heated. Low voltage is necessary, in order that the current may not flow rather through the molten glass, which is a good conductor; and the resistance of the nozzle plate D must therefore be smaller than that of the over-lying glass. By this means the glass which flows out is given a temperature of 1500° to 1600° C., depending upon its character. It now flows through the orifices O upon a second nozzle plate, the so-called blowing plate, Bl, whose distance from D can be adjusted to requirements.

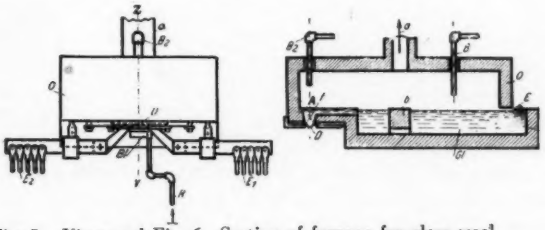


Fig. 5. View, and Fig. 6. Section of furnace for glass wool.

This blowing plate contains the blowing nozzles, in the form of concentric rings, for the passage of the super-heated steam, or highly pre-heated air, for the blowing of wool. These surround the fluid glass stream concentrically, and pull it along at great velocity, so that it is torn into thin fibers. The pressure of the blast medium, also the cross-section and form of the blast nozzle Bl must be so designed, that suitable blast velocity (which now replaces the above-described drawing velocity of the threads) is generated for the production of proper fiber diameters. This velocity is 2 to 3 meters per second for large threads, and 40 to 50 meters per second for thin fibers. (6 to 10 ft./sec., and 130 to 160 ft./sec., respectively.)

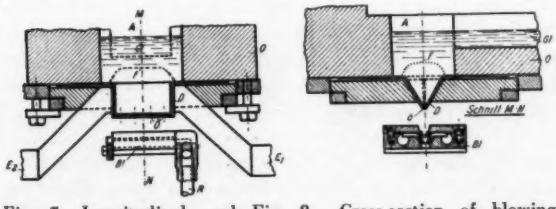


Fig. 7. Longitudinal, and Fig. 8. Cross-section of blowing apparatus for glass wool.

The continuous drawing process (with a drum) permits the use of small machines, which may be fitted to such manufacture. But the centrifugal and the blowing processes require large and expensive equipment, which operates economically only in mass production.

Processing and Use of Glass Fibers

The applications of glass fibers in the arts are varied. They provide a sort of incombustible silk or wool, which has a softness much like the natural silk or wool, provided that the fibers are not larger than 0.02 mm. (0.0008"). As early as 1904, it was suggested that this material might be used for heat insulation. At first, the cost interferred, but later, as economical production methods were learned, this use expanded. In fact, it is one of the best and most convenient heat insulators known to the arts. In practice, it is well to recognize that the efficiency of glass wool as a heat insulator increases with its bulk density until a maximum is reached, and then drops off as bulk density increases further. This maximum lies at a higher bulk density, the higher the temperature of the body or object to be protected is.

It is also important to note, that to avoid permanent changes in shape of the material it must be applied in a limited bulk density, which fortunately coincides with that at which the maximum value for thermal insulation is present. Numerically, the above specification comes out as follows: with a bulk density of 140 to 220 kg./m^3 [8.7 to 13.7 lb./ft.^{3}] permanent change of shape begins, at a load of 30,000 kg./m^2 [40 lb./in.^{2}], to be noticeable. However, at the same bulk density comes maximum insulating efficiency. In order to fit the material for practical use as an insulator, it is applied as bands, tubes, blankets, shells, mattresses, etc.

Recently, there has been discovered the unusually high sound-deadening or silencing property of fibrous glass, whether it be for stopping sound from passing through a wall, or for preventing reverberation and echoes and thus assuring good acoustics. Important considerations are, that the effectiveness of the material is extraordinary and unequalled by other materials, also that this effectiveness is very uniform throughout all ranges of tone pitch, as with no other sound-proofing substances. With high or low tones, the effect is the same. Hence glass wool has recently become popular as a sound insulator.

These excellent heat- and sound-insulating properties of the material have led to its use in double window panes with an intermediate layer of glass fibers. The layer is 1 to 5 mm. thick, depending upon the use of the pane, and at the edges the double sheets are held together by a water-proof putty or cement. Such windows transmit light very well, and give the impression of a very light milky glass. A double pane, with 1 mm. layer of glass fibers, transmits 76 per cent of the light (opal glass only 47 per cent). The fibrous layer scatters the light as would many thousands of tiny prisms, so uniformly, that a practically shadow-less light enters the room,—especially desirable for operating rooms, show rooms, work places, etc. Since all corners of the room are equally lighted, it appears lighter than with normal lighting through ordinary windows. Street noises are greatly reduced, for the noise-deadening effect of such a pane with 3.5 mm. of glass-fiber layer is 41 decibels (at 1000 Hertz). That means, that of the great noise of a traffic street in a down-town section amounting

to 70 decibels loudness, about 40 decibels are stopped. The remaining 30 decibels correspond to the noise of a quiet street in the suburbs.

The heat-insulating value of a pane of the kind just described is about the same as that of a wall one brick in thickness. In this combination pane we have a type of building construction valuable for temperature control, sound-proofing, and light transmission, which provides for the construction of well-lighted rooms and houses which shall be equal to stone or cement structures in heat- and sound-insulation.

Interesting and wide-spread is the application of fibrous glass as a sound-insulating material in the mufflers of internal combustion motors and in exhaust pipes. The swiftly increasing popularity of Diesel-powered cars with their very loud exhausts invites a broader application of such sound-proofing as something very desirable.

A further extended field of usefulness for the materials is its application in a sort of plastic plate between the metal plates of electrical accumulators (storage batteries). Plates of this sort permit the construction of cells of low resistance whose current capacity can be increased by 40 per cent; the durability of such plates and in consequence of the batteries is very great, so that for batteries of this kind, a three-year guarantee is given. The 40 per cent increase in charging current is of especial interest since the problem of the construction of successful electrically driven vehicles depends upon the building of storage batteries of high conductivity.

As a filter material, glass fibers find extended use in the chemical arts. They are used further as an inorganic inlaid fabric with bitumen, asphalt, or resinous plates. There have also been made, from these fibers, insulating strips with which, for example, pipes laid in the ground may be covered for protection against rust which may be produced by moisture or by the electric currents in the earth. The puncturing voltage of such a one-mm. thick covering made from a resin-soft gum mixture with glass-fiber inlay reaches about 4000 volts. As protection against rust, these wrappings have served well in moist volcanic earth. Glass fibers have also been used as an inlay in artificial resins in order to improve their mechanical properties.

Glass fibers have, as already mentioned, a glistening, shiny appearance, and since they can also be made from colored glasses, they lend themselves to the production of various decorations such as Christmas-tree ornaments, lamp shades, and other fancy pieces. Products of this kind are being produced in quantity, especially in the home industries. Polishing pencils can be made out of parallel-laid and cylindrically-wrapped stiff bundles of glass fibers which are not attacked by any acid with the exception of hydrofluoric acid, and by no kind of alkali.

Glass fibers are being made ever thinner and more flexible. The farther the art progresses there is more definite hope, that soon we shall be able to spin from glass fibers a perfect thread, capable of being woven; and then it will also be possible to fabricate the material as an electric cable insulator and a technical fabric.

A chapter on Arsenic in the 1936 Minerals Yearbook points out that six per cent of the 1935 domestic sales of white arsenic were distributed to the glass industry.

THE NEW YEAR AT ALFRED UNIVERSITY

Three hundred and twenty-six students are enrolled in the New York State College of Ceramics at the present time. This enrollment is about equally divided between the departments of General Ceramic Technology and Engineering, Glass Technology, and Ceramic Art. The enrollment is kept down to this figure by accepting only those applicants whose scholastic records in high school indicate they have more than average ability and adaptability to the course. One interesting feature this year is the large number of students from families prominently identified with the ceramic industry.

Research is being emphasized this year. The establishment of research has furnished the necessary facilities. That department is now in full operation with H. G. Schurecht, J. F. McMahon, and C. Major Lampman devoting all their time to research. The progress of their work is reported monthly to the ceramic industries. Two industrial fellowships are now in operation and they effectively supplement the work of the Department of Research.

The annual Christmas Festival was held on Dec. 11th with its usual exhibit of pottery made by students. On March 18th and 19th the annual St. Patrick Celebration will be held and on May 15th the annual Meeting of the Ceramic Association of New York will be held. The ceramic public is cordially invited to attend these meetings.

Monthly meetings are held by the Student Branch of the American Ceramic Society. The attendance is usually about 150. At the Oct. meeting Dr. Louis Navias spoke on glass; at the Nov. meeting Dr. A. I. Andrews spoke on enamels; at the Dec. meeting Ernest Knapp spoke on deairing. Dr. G. W. Morey is scheduled to speak at the Jan. meeting and Dr. Heinrich Ries at the March meeting.

The employment situation is such as to indicate a shortage of ceramic graduates. Recent employment of graduates of this institution include the following: J. Eugene Deegan, Glen Gary Brick Co.; Joseph Sarandria, Joseph Dixon Crucible Co.; Russell Miller, Refractories and Insulation Corporation; and Robert Childs, Corning Glass.

A CORRECTION FROM ENGLAND

A. R. Woods of Pilkington Brothers, Ltd., St. Helens, Lancs., England writes as follows: "I should like to draw your attention to the reference in the November issue of The Glass Industry, on page 372, to my method of determining the alkali content of glasses, by means of thin film.

"In the article the small sample is given as only 20 m/grms, whereas this should read 80 m/grms.

"I think it is important that this should be corrected, particularly in view of the discussion which followed at the meeting. The full account of my method was published in the Transactions of the Society of Glass Technology 1935, vol. 19."

Certain changes in the Commercial Standard on Fuel Oils, CS12-35 have been approved by the Standing Committee of the National Bureau of Standards, which is identical with Section I, Technical Committee C of ASTM Committee D-2. These changes have been submitted to producers, distributors and users for written acceptance prior to publication by the Bureau.

THE EFFECT OF THICKNESS ON THE COLOR OF RED SIGNAL GLASSES

By ROGER S. ESTEY
Electrical Testing Laboratories

In a previous paper (The Colorimetric Design of Red Signal Glasses, The Glass Industry, 17, 409, 1936) the author described the color diagram and demonstrated its usefulness in the solution of color problems associated with the design of red signal glasses. Test methods were discussed by which, with the aid of color standards, glasses meeting any desired specifications could be selected. No suggestions, however, were made for improving the quality or adjusting the color of the product to meet these specifications. The following paper will show the effect of thickness or concentration of coloring material on the color of the sample and will correlate thickness with hue and light transmission.—The Editor.

Any red glass is characterized by its spectrophotometric curve. The steepness of the curve from zero to maximum transmission and the transparency of the highly transmitting region control the light transmission of the sample. The wave length band within which the transmission occurs determines the hue and color. These characteristics are controlled by varying the amount or nature of the coloring agent. Obviously no theoretical discussion could predict the effect of a change in the type of coloring agent but the effect of changes in the amount of the same coloring material can be easily computed.

The selective absorption of light in any material is due to the action of certain light absorbing molecules and if the composition of the material permits each molecule to absorb independently of the presence of neighboring molecules then the absorption is proportional to the number of selectively absorbing molecules in the light path and any change in the concentration of absorbing molecules produces a proportional change in the absorption. Colored materials for which this proportionality is true are said to obey Beer's law. If the coloring matter is uniformly dispersed through the thickness of the glass then any change in thickness will always produce a corresponding change in the light absorption. It is understood that in the case of many colored glasses the color does not change with concentration of coloring agent in the manner predicted by theory. In such cases the empirical relationships can be determined from experiments made on a series of glasses and the results applied in a manner similar to the present discussion.

The effect of thickness (or concentration, if Beer's law is obeyed) on the color of typical red glasses was studied by computing the color data for a range of thicknesses for several of the simplified samples described in the previous paper and for two actual glasses, one red and one orange. The simplified samples comprised three types of spectrophotometric curves passing by straight line transitions of different slope from zero

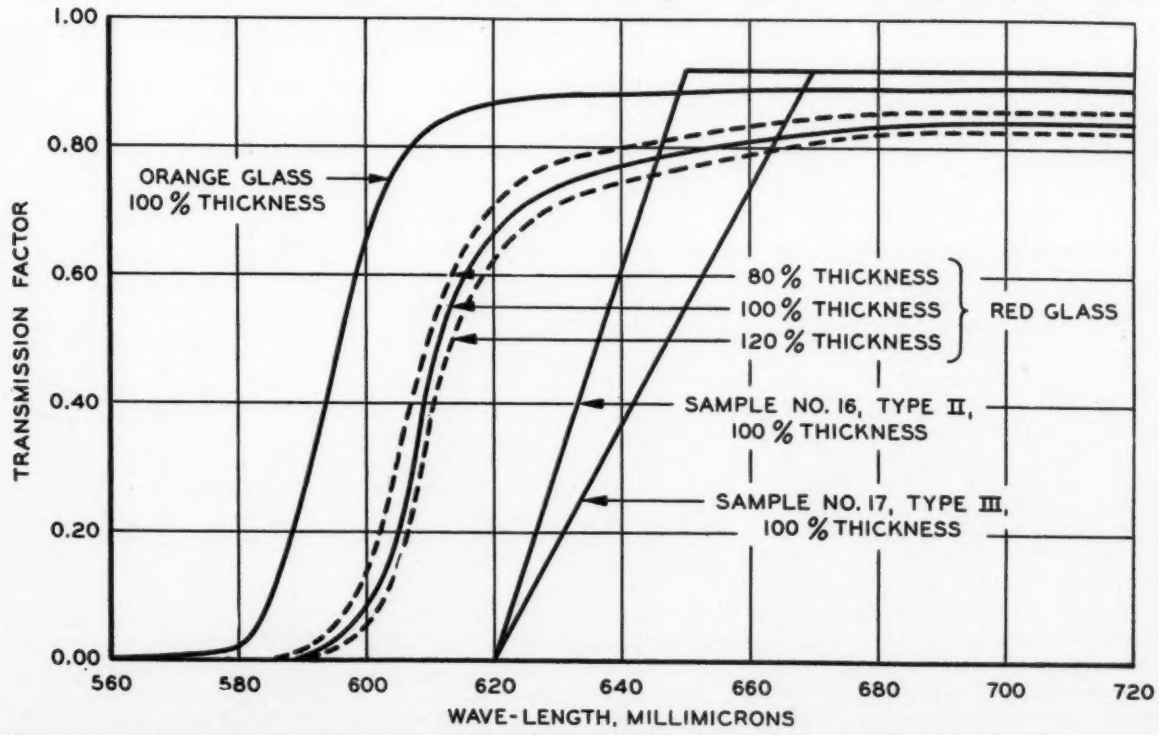


Fig. 1. Spectrophotometric Curves for Two Glasses and Two Simplified Samples. The effect of thickness variation is shown.

TABLE I. COLORIMETRIC DATA ON SAMPLES AT VARIOUS THICKNESSES.

Sample No.	Type	Per Cent Thickness	λd	Transmission Factor	Thickness Coefficient of Hue	Thickness Coefficient of Transmission	Relative Transmission Coefficient
		60	612.5	0.292			
		80	613.6	0.280			
4	II	100	614.5	0.270	0.0425	0.00048	0.18
		120	615.3	0.261			
		140	616.2	0.253			
Orange		80	612.8	0.273			
glass		100	614.4	0.257	0.0625	0.00068	0.26
		120	615.3	0.246			
		80	616.1	0.225			
5	III	100	618.0	0.208	0.0875	0.00078	0.37
		120	619.6	0.194			
Red		80	623.4	0.159			
glass		100	624.9	0.145	0.0700	0.00062	0.43
		120	626.2	0.134			
		60	627.3	0.159			
		80	628.3	0.150			
10	II	100	629.2	0.143	0.0475	0.00036	0.24
		120	630.2	0.136			
		140	631.0	0.131			
		80	630.4	0.115			
11	III	100	632.0	0.104	0.0800	0.00050	0.48
		120	633.6	0.095			
		60	643.0	0.070			
		80	644.0	0.065			
16	II	100	644.9	0.061	0.0475	0.00018	0.28
		120	645.9	0.058			
		140	646.6	0.055			
		80	645.6	0.049			
17	III	100	646.9	0.043	0.0725	0.00028	0.64
		120	648.5	0.038			

to 92 per cent transmission factor. Several samples of each type were investigated, each differing in cut-off wave length and in dominant wave length or hue. These simplified samples are drawn from the complete set of samples similarly numbered and shown in the table in the previous paper. Type II samples 4, 10 and 16, type III samples 5, 11 and 17 and the red and orange glasses were computed to 80 and 120 per cent thickness. Some were also computed to 60 and 140 per cent thickness as well. Examples of the resulting spectrophotometric curves are shown in Fig. 1. The data on all of these samples are shown in Table I.

The sample numbers permit reference to the data in the previous article. Types II and III refer to simplified spectrophotometric curves sloping from zero to maximum transmission in 30 and 50 millimicrons of wave length respectively. The dominant wave length is represented by λ_d. In the next column is shown the transmission factor of the material for tungsten light. The coefficients in the last three columns are of particular interest. The thickness coefficient of hue is the number, characteristic of a particular glass, by which any per cent change in thickness must be multiplied to determine the corresponding change in hue. The coefficient is expressed in millimicrons of dominant wave length change produced by one per cent change in thickness. The thickness coefficient of transmission is the number, characteristic of a particular glass, by which any per cent change in thickness must be multiplied to determine the corresponding change in transmission. This coefficient is expressed in units of change in transmission factor produced by one per cent change in thickness. The relative transmission coefficient is the thickness coefficient of transmission divided by the transmission factor at the standard thickness when the latter is expressed in per cent.

Fig. 2 shows values which the hue coefficient may have under typical conditions. The coefficients of the three type II samples (lower curve) and the coefficients for the three type III samples (upper curve) are on either

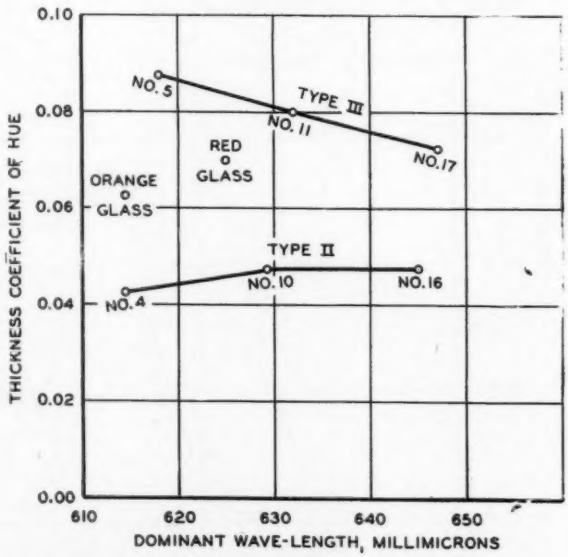


Fig. 2. Thickness Coefficient of Hue. The hue coefficient is the millimicron change in dominant wave length due to one per cent change in thickness.

side of the values for actual glasses, indicating that the simplified curves are a fair approximation to actual glasses and that the coefficient does not vary markedly for different types of red coloring material. One can say roughly that a sharp cut-off red glass will change about 0.07 millimicrons in dominant wave length for a one per cent change in thickness. It is evident from examining the differences between successive values in column λ_d that the relation between thickness and dominant wave length is practically linear over the range investigated. Therefore the thickness coefficient of hue may be assumed reasonably accurate over a range of about 40 per cent from the standard thickness.

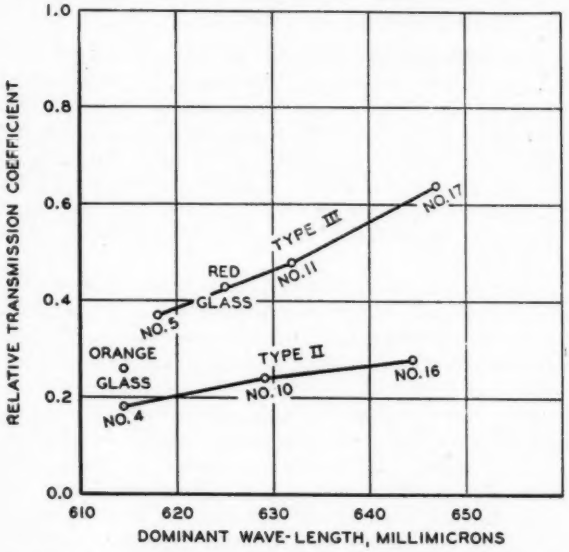


Fig. 3. Relative Transmission Coefficients. These are the thickness coefficients of transmission divided by the per cent transmission factor at the standard thickness. It represents the per cent change in transmission due to one per cent change in thickness.

The thickness coefficients of transmission are only accurate for values near the standard thickness and they also vary too much with the transmission factor to be of much value. Their value is increased somewhat by converting them to the relative transmission coefficients. These are plotted against dominant wave length in Fig. 3. A change in relative transmission of less than one per cent is of no practical consequence because it could scarcely be detected except by photometric tests of considerable delicacy. The relative transmission coefficients range from 0.2 to 0.6 which means that even 10 per cent change in thickness would produce only 2 to 6 per cent change in transmission from standard.

Figs. 2 and 3 show that as a red glass is improved by increasing the steepness of slope and sharpness of cut-off of its spectrophotometric curve its two properties, hue and light transmission, change more slowly with changes in thickness (or concentration of coloring matter if Beer's law is obeyed).

Obviously the constants for any particular glass would have to be determined by experiment, but the above figures show the range of magnitudes to be expected and are useful for rough estimation. Spectrophotometric data treated as suggested in this article may help the glass maker in pulling off-color glass into line.

MISSISSIPPI DEVELOPS NEW GLASS WARE

One of the most interesting developments of the New Year is the entry of the Mississippi Glass Co. into the business of manufacturing glass dishes, lenses and other ware of this type, which is being distributed by Fiscer-Bruce Co., Philadelphia. The chief features of this new type of glassware, in addition to the attractive designs which may be employed, are its amazing lightness combined with strength.

The process is, in general, the same as that for manufacturing flat glass, except that a very definite refinement of that process is involved. The original annealing takes place in the normal course of making flat glass. Strips are then cut off and many which otherwise go to the cullet pile are shipped to the Morgantown, W. Va., factory for a process of bending and subsequent reannealing. Open molds designed by an associate of Norman Bel Geddes, eminent industrial and scenic designer, are used to create the interesting shapes.

A rotating oven, 12 feet across, has been constructed by the Amsler-Morton Co. for the bending operation. The real trick in the operation is the use of a particular type of fire blast. Almost any size or shape can thus be made out of glass that might otherwise go to waste. It is also possible to make lenses for illuminating such objects as display and show cases.

Many of the leading New York department stores are showing examples of this important new development. Typical samples of the various sizes and shapes will be on exhibit in Room 873 at the William Penn Hotel, Pittsburgh, during the annual show of the Association of Glass and Pottery Manufacturers, Jan. 11-20.

DR. BASS REJOINS MELLON INSTITUTE

Dr. Lawrence Wade Bass has been appointed a member of the executive staff, according to an announcement from the Mellon Institute of Industrial Research. Dr. Bass served as executive assistant at the Institute from 1929 to 1931 and is returning to that organization as assistant director after being connected with the Borden Co., New York, for six years, first as assistant director of research, then, since 1932, as director of research. His appointment is effective as of Jan. 1.

PUBLIC DEMONSTRATION OF POLAROID

The first demonstration to the public of the preparation of Polaroid was given, Dec. 9, at the Museum of Science and Industry, New York, by Edwin H. Land and George W. Wheelwright, III. The demonstration was followed by a talk by J. M. Arthur, formerly professor of science at St. Marks School, on the applications of the new substance. Applications include: the elimination of head-light glare; the three-dimensional motion picture in color; sun glasses which eliminate glare of reflected light; detection of strain in glass; the Pola-screen lens for photography; and cellophane colors and theatrical decorations.

Metal Products Exhibits, Inc., announces an "Aircraft in Industry" exhibition to be held in Rockefeller Center, New York, which will close on Jan. 15. Included will be the various devices which make airplane travel safe, including an exhibit of safety glass.

GERMAN GLASS WOOL DEVELOPMENTS

Glass wool* as a means of heat insulation has been known in Germany since 1904 but the high cost of production for a long time limited its use. In recent years, with improvements in production methods reducing costs, glass wool has become one of the most efficient and popular insulation materials on the market. Its efficacy in sound insulation has added greatly to its utility in modern construction.

One of the greatest advantages of glass wool is its adaptability in the matter of form to particular insulation problems. It is now available for heat insulation in ribbons, tubes, covers, cups, pads and various other forms and shapes. As sound insulation it is reputedly more efficient than any other material so far used, partially because it is equally effective against sounds of any pitch.

A new development which makes use of the qualities of glass wool as an insulation against both heat and sound is its use in double windows. For this purpose a layer of glass wool from 1 to 5 mm. thick is placed between two panes of glass cemented together at the edges. The double window formed in this way is semi-transparent, like very clear milk glass, a pane with a 1 mm. layer of glass wool, for example, having a light transmitting capacity of 75 per cent (as compared with only 47 per cent for opal glass). Aside from its chief purpose as a heat and sound insulation, a window of this type has the added advantage that it diffuses the light so as to make an almost shadowless room and is thus particularly well adapted for use in hospitals, schools, studios, etc. Because of the more even diffusion a room so lighted actually appears to be brighter than one served by ordinary windows. Against noise the glass wool double window has an insulating effectiveness of 41 decibels (with 1000 Hertz), sufficient to reduce the noise of a city street by more than half. As a heat insulation the double window is the equivalent of a wall one brick in thickness.

Glass wool is also being used in mufflers and exhaust pipes of internal combustion engines. It is said to be well adapted to muffle the loud exhausts of Diesel engines.

Thin plates of glass wool between the metal plates of electric accumulators have proved very effective in increasing the capacity and durability of the apparatus. An accumulator so constructed is said to have 40 per cent more receptivity to current and can be guaranteed for three years.

Glass threads have successfully been employed as chemical filters where their immunity to acid and alkali is a marked advantage. Similarly bundles of glass threads replace bristles or wires in polishing brushes especially where there is contact with acid or alkali. Glass wool is also used between layers of tar, asphalt or resin as insulation in underground works and, in ribbon form, around buried pipes as a protection against rust due to dampness or to electric earth current. Because of the decorative quality of the glass threads, particularly when spun from colored glass, glass wool is well suited for ornamental purposes. It is thus being used extensively for Christmas tree ornaments, wigs, lamp shades and other novelties.

The technical problems in connection with the use of glass wool as a substitute for textile fibers have been solved but so far little commercial use has been made of glass for this purpose. When a glass thread suitable for use in wefts has been developed it is expected that considerable use will be made of glass fabrics especially for technical purposes, such as the insulation of electrical cables.

Glass wool is marketed in Germany chiefly through agents though some manufacturers maintain sales branches in principal cities. On account of the nature of the product and the necessity in many cases of adapting forms to particular uses it is impractical to maintain retail stocks. Distributors usually keep samples on hand from which orders are taken.

*From a report by Trade Commissioner R. M. Stephenson, Berlin, released through the courtesy of the Specialties Division of the Bureau of Foreign and Domestic Commerce.

1936 INCANDESCENT LAMP SALES UP

A preliminary estimate of the number of incandescent lamps sold in the United States during 1936 indicates a total of more than 880,000,000, an increase of 19 per cent over the previous high total of 1935, according to a review of the electrical industry prepared by John Liston of the General Electric Co. The figure for large lamps is 460,000,000, and for miniature lamps is 420,000,000.

Among outstanding developments of the year was the introduction of two screens or grids within a new 1000-watt general-service lamp to collect much of the blackening that was formerly deposited on the lamp bulb. This lamp, equipped with a medium bi-post base and an inside-frosted tubular bulb, is of special heat-resisting hard glass and permits accurate focusing of the filament.

More miles of highway were illuminated during 1936 than during the preceding five years, Mr. Liston reported. The world's longest bridge, the San Francisco-Oakland Bay Bridge, is appropriately lighted with the golden light of more than a thousand 10,000-lumen sodium luminaires. The longest sodium highway-lighting installation in the world, along the Duanesburg Road in New York State, is 17½ miles long and utilizes 390 10,000-lumen units. A radically improved highway-lighting system employing a new incandescent lamp and a totally new concept in luminaires was also developed.

AMERICAN CERAMIC SOCIETY MEETING

An extremely promising entertainment schedule for the 39th annual meeting of the American Ceramic Society at the Waldorf-Astoria Hotel, March 21-27, has been announced by R. L. Clare, chairman of the local entertainment committee. Starting with a "Get together" dance at the Waldorf on the 22nd, the program will carry on through various points of interest in New York, including a visit to the R. M. S. "Queen Mary," the beauty of whose glass decorations are elsewhere described in this issue, as well as an evening at the French Casino. An interesting program is also being planned for the ladies.

NOVEMBER PLATE GLASS PRODUCTION

The Plate Glass Manufacturers of America have announced that the production of polished plate glass by its member companies in Nov. 1936, was 13,083,963 square feet as compared to 20,752,657 square feet produced in October and 15,909,262 square feet produced in Nov. 1935. This makes a total of 190,697,602 square feet produced in the first eleven months of 1936.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	40.00	45.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	...	...
Granulated	In bags, lb.	.022	.0245-.027
Powdered	In bags, lb.	.0245	.027-.0295
Boric acid (H_3BO_3) granulated	In bags, lb.	.05	.0525-.055
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08½	.09
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	31.50	
In bags	ton	33.10	38.00-40.60
Kryolith (see Cryolite)			
Lead oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.08	...
In 5 Ton lots	lb.	...	.09
Less than 5 Tons	lb.	...	.095
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	
Burnt (CaO) ground, in bulk	ton	7.00	
Burnt, ground, in paper sacks	ton	9.00	
Burnt, ground, in 280 lb. bbls	Per bbl.	2.25	2.25
Calcined (K_2CO_3) 96-98%	lb.	.06⅞	.07⅜
Hydrated 80-85%	lb.	.06	.06¼-.06⅜
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	...
In barrels	Per 100 lb.	1.35	...
In bags	Per 100 lb.	1.10	...
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	Per 100 lb.	...	2.25-2.65
95% and 97%			
Bulk	Per 100 lb.	1.275	...
200 lb bags		1.34	1.39
100 lb. bags		1.375	1.425

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	...	.03½
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Antimony oxide (Sb_2O_3)	lb.	...	.13
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03¼
Barium nitrate ($Ba(NO_3)_2$)	lb.	...	.07¾
Rutile (TiO_2) powdered, 95%	lb.	.10-.12	.13-.15
Sodium fluosilicate (Na_2SiF_6)	lb.	.06½	.0725
Tin oxide (SnO_2) in bbls	lb.	...	.55
Zinc oxide (ZnO)			
American process, Bags	lb.	.05¼	.05½
White Seal, 150 lb. bbls.	lb.	.07	.07¼
Green Seal bags	lb.	.06¼	.06½
Domestic White Seal bags	lb.	.06¾	.07
Red Seal, bags	lb.	.05¾	.06
Zircon			
Granular (Milled .005-.02c higher)		.07	.67½ .08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	...	1.50-1.75
(Commercial, 25% Selenium)	lb.	...	.90
Cadmium sulphide (CdS)—	lb.	...	.90-.95
Chromite	lb.	...	.0215
Cerium hydrate			
100 lb. drums and 600 lb. barrels	lb.	...	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	.20	.215-.25
Cobalt oxide (Co_2O_3)			
In bbls	lb	...	1.41
In 10 lb. tins	lb.	...	1.51
Copper oxide			
Red (Cu_2O)	lb.	...	.20
Black (CuO)	lb.	...	.17
Black prepared	lb.	...	.22
Iron oxide—			
Red (Fe_2O_3)	lb.	...	.0425
Black ($Fe3O_4$)	lb.	.04½	...
Iron chromate	lb.	...	.035-.05
Lead chromate ($PbCrO_4$)	lb.	...	.16
Manganese, Black Oxide			
In Paper bags	ton	47.50	50.50
In Burlap bags	ton	49.50	52.50-57.50
In Casks	ton	51.50	54.50-59.50
Neodymidm oxalate, 50 lb. drums	lb.	...	$3.00
Nickel oxide (Ni_2O_3), black	lb.	...	.35-.40
Nickel monoxide (NiO), green	lb.	...	.35-.40
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	...	.09
Powdered	lb.	...	.09½
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	...	.27
Powder blue	lb.	...	.18¼-.19¼
Rare earth hydrate			
100 lb. drums	lb.	...	.35
325 lb. barrels	lb.	...	.30
Selenium (Se) In 100 lb. lots	lb.	...	2.00
In lesser quantities	lb.	...	2.10
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	...	.08¾
Sodium selenite (Na_2SeO_3)	lb.	..	1.80 2.00
Sodium uranate (Na_2UO_4) Orange	lb.		1.50 1.55
Yellow	lb.	...	1.50-1.55
Sodium uranyl carbonate	lb.	...	.80-.90
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.35	3.70 4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	...	2.25
Yellow orange	lb.	...	1.50

EQUIPMENT AND SUPPLIES

DEVELOPS NEW "DUST BOOT" FOR GLASS BATCH MIXERS

T. L. Smith Co., Milwaukee, manufacturers of batch mixers since 1900, have recently designed a new device for preventing the escape of dust at the discharge side of a glass batch mixed during the entire mixing cycle.

The device is called a "dust boot" and consists of a stationary rectangular casing with three straight sides and one concave side facing the mixer. All three sides, as well as the top, are closed completely to make dust escape impossible. The bottom is equipped with a gate which can be opened only while the mixer is discharging. If desired, the bottom of the boot can be so arranged that the container or cart, taking away the mixed batch, will match the opening, thus forming a tight joint during the entire discharge period.

The concave side of the boot is covered by a radial shield which is connected to the tilting frame of the mixer and moves with the drum as the latter is being tilted for discharge. The seal between the rotating mixer drum and the radial shield consists of a floating sealing ring which is mounted on the cylindrical portion of the mixer drum. This ring moves in a companion ring which is securely bolted to the radial shield.

GLASS FEEDER CONTROL

The Foxboro Co., Foxboro, Mass., have developed their automatic control systems for glass feeders and report successful industrial installations in operation during 1936. The equipment consists of Stabilog pressure controllers on the spout burner, and the channel burner, a Stabilog potentiometer temperature control pyrometer regulating spout temperature, and a potentiometer recording pyrometer, 2-record type, which records the temperatures of spout and channel.

PIVOTED MOTOR BASES FOR V-BELT DRIVES

Rockwood Manufacturing Co., Indianapolis, are now bringing out their V-belt drives on pivoted motor bases. It is said that when these V-belts are used with its resultant faster belt wear, is automatically taken up, and belt slip, eliminated. When the drive is not running the tension is removed from the belts thus permitting the belt to "rest." The company reports that users estimate that the use of these bases increases V-belt life somewheres around 50 per cent. While the company sells the complete Rockwood drive with their own V-belts, the bases may be purchased separately to use with existing V-belt drives.

● Illustrated is the Smith Tilting Mixer being tilted for discharging.

General Refractories Co., Philadelphia, has announced the appointment of H. R. Weller as district sales manager at Cleveland. Mr. Weller succeeds John C. Hopkins who has resigned to become associated with the Wellman Engineering Co.

CATALOGS RECEIVED

Electric Recorders. No. 436. The Bristol Co., Waterbury, Conn. A new 24-page bulletin which describes the company's new round-chart electric recorders, both ammeters and voltmeters.

9-inch Workshop Precision Lathe. South Bend Lathe Works, South Bend, Ind. 24 pages and 150 illustrations are used to show the seven new styles, features and applications of the new back-geared screw cutting lathe. Also presented are methods and tests for high degrees of accuracy.

Tag Oil Testing Instruments. No. 699D. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y. This book lists and describes the company's complete line of oil testing instruments, hydrometers and thermometers, and also offers an official guide to the principal tests on petroleum products.

Amsco Material Handling Pumps, Pipe Line Fittings and Rotary Dredge Cutter Heads. American Manganese Steel Co., Chicago Heights, Ill. A fully illustrated catalog with a questionnaire so that readers may check their needs.

Bulletin TS 3000. Precision Scientific Co., 1750 N. Springfield Ave., Chicago, Ill. Tells how to conduct accurate B. t. u. tests with a flow type calorimeter. Also includes essential calorimetric tables reproduced from Bureau of Standards Circular No. 65. *Bulletin TS* 3110 contains useful information and operating instructions pertaining to wet test laboratory gas meters.

Ceramic Products Containing Zinc Oxide. No. 8. New Jersey Zinc Co., 160 Front St., New York. An interesting folder listing the effect of zinc oxide on ceramic and glass products.

Index of Applications. No. R-90. Manganese Steel Forge Co., Philadelphia. Of particular interest to those who have maintenance difficulties due to abrasion or breakage of metal parts.

The Graham Variable Speed Transmission. Bulletin No. 302. Fellows Gear Shaper Co., Springfield, Vt. Diagrams and photographs aid in presenting the details about this important machinery.

LOADER FOR BULK MATERIALS

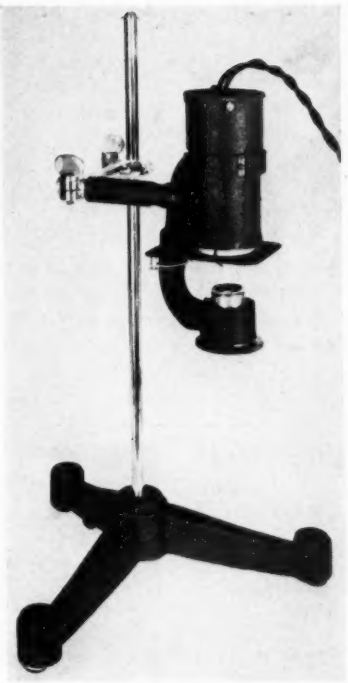
Link-Belt Co., Philadelphia, have developed a new type of inexpensive box car loader for handling bulk materials without creating a lot of dust or degradation in the operation. The antifriction belt conveyor constituting the loading element of the machine, is supported on a horizontal boom which is arranged so that it can be racked back and forth or rotated 360 degrees by hand, on the castor-mounted truck on which the boom is mounted. The conveyor is operated at a comparatively slow speed and has a discharge height of five feet.

PROJECTION LANTERN FOR POLARIZED LIGHT

The Polarizing Instrument Co., New York, advise that they recently perfected a projection lantern which may be used for either ordinary or polarized light. A compact instrument it is said to be particularly adapted to the projection of prepared slides, living organisms, liquid specimen, crystals, fibers or other samples. Equipped with Polaroid, it provides for projection in polarized light.

The apparatus is mounted on a tripod base which permits rotation about a vertical or horizontal axis. The size of the image can be increased or diminished by raising or lowering the apparatus on the stand rod. By revolving the projector through 90 degrees so that the optical axis is in a horizontal position, the projector can be used for horizontal projection on a screen. A mirror is not required to make this change, thus maintaining maximum light efficiency.

The company also advises that projection is provided for work in parallel polarized light and a set of accessory condensers is available for projection in highly convergent light for the projection of interference figures.



● The Polaroid-equipped universal angle projection lantern is very small, being only seven inches in length and weighing about two pounds. This instrument is designed for low power magnification (about 20 diameters).

NEW FORMS FOR SOCIAL SECURITY RECORD-KEEPING

Since, under the Social Security Law every employer is required to set up and keep many new records, new forms for so doing have been devised by the Acme Card System Co., 8 South Michigan Ave., Chicago. The Company advises that it has developed visible record equipment for the smallest as well as the largest organizations. For the records of an employer having not more than 14 on the payroll, there is a visible record book; for from 30 to 50 employees, a larger sized binder of the same kind is available; for employers of 300 or more are tray cabinets.

P. B. Sillimanite Feeder Parts...

● ● *give nationally known glass products manufacturer unusual service*

This manufacturer is so well pleased with P. B. Sillimanite Feeder Parts that he writes, in part: "Tank finally down after 13 months' run. Could have run for another two or three months. Clay spouts averaged about six months."

It is not an experiment with his company. They have been using P. B. Sillimanite Feeder Parts for three years, and their records show that P. B. Sillimanite Feeder Parts will last more than twice as long as ordinary materials.

Why be satisfied with less? Tell us about your toughest job. Our Engineering Department may make some valuable suggestions.

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All P. B. Sillimanite made by The Chas. Taylor Sons Company bears this trade-mark—your guarantee of satisfaction.

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OVERMYER EXECUTIVES CAST IN SAME MOULD

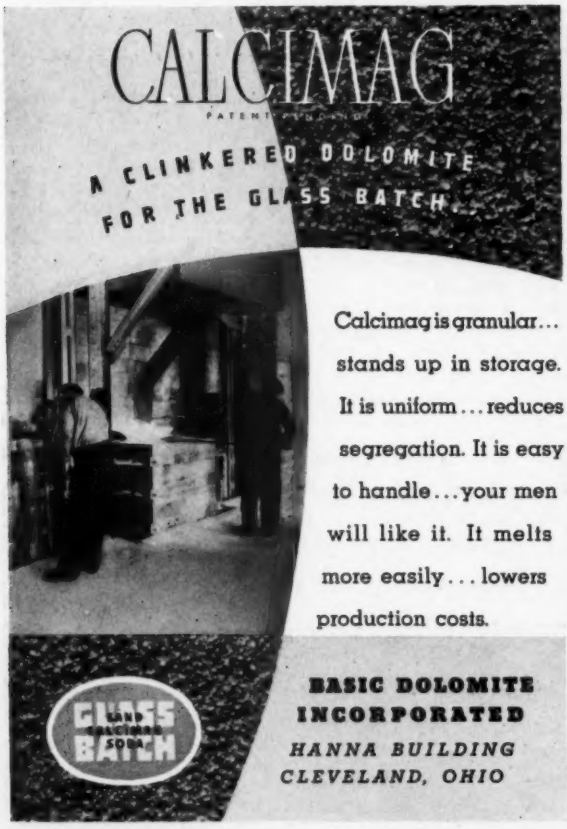
To the Overmyer Mould Co., Winchester, Ind., goes The GLASS INDUSTRY's annual award for the most original Christmas card received. The "card" is a bottle containing maple syrup. On one side S. Claus is indulging himself in a stack of wheats and syrup. Above him, the indicia, "1936 Merry Christmas," and below, the company's signature. The backside shows the frontside of the Overmyer executives, all cast in the same mould. There's C. P. O. himself, young Chet, Mort Don and Ced —to all of them again, greetings.

INTERNATIONAL GLASS CONGRESS REPORT

A detailed account of the proceedings of the International Congress on Glass which was held in London, England, in July 1936 is now available in the August 1936 issue of the *Journal of the Society of Glass Technology*. In addition to the technical papers and illustrations, there are many human interest photographs of the members at work and play. The price is 10/-d. each, and orders for copies should be sent directly to Professor W. E. S. Turner, Society of Glass Technology, Darnall Road, Sheffield 9, England.

DR. SILVERMAN HONORED AT ALFRED

Professor Alexander Silverman head of the Department of Chemistry of the University of Pittsburgh, was the recipient of the honorary degree of Doctor of Science on the occasion of Founders' Day, celebrating the one hundred and first anniversary of the granting of the charter of Alfred University, Alfred, N. Y.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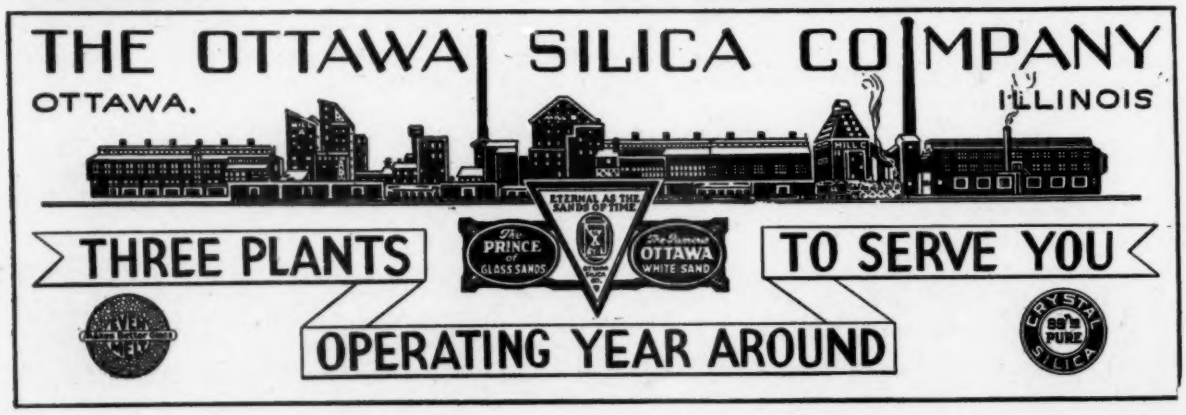
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